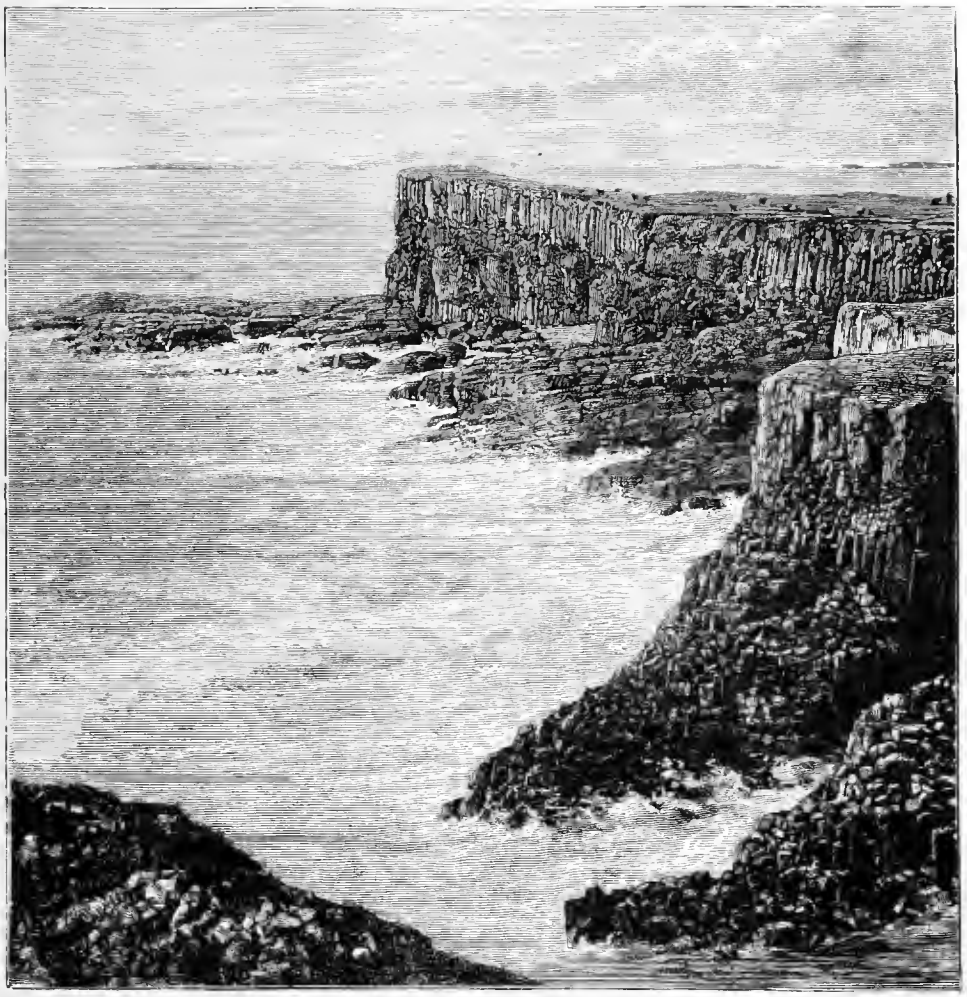
Is Fingal's Cave Artificial?

By F. COPE WHITEHOUSE, M. A.



STAFFA: VIEW TAKEN FROM THE TOP OF A CLIFF.

Reprinted from

"THE POPULAR SCIENCE MONTHLY,"

DECEMBER, 1882.

New York: D. APPLETON & CO., 1, 3, & 5 Bond Street.

The Head of Loch Fyne.

IS FINGAL'S CAVE ARTIFICIAL?*

By F. COPE WHITEHOUSE, M. A., etc.

IN venturing to ask a question and thus imply a doubt upon a point on which geologists, statesmen, and poets have given their consentient opinion for a century, it is not without regret that an opinion, held without suspicion of challenge, should be subjected to criticism, and better proof than prescription required for the title by which this celebrated cavern has been held and enjoyed as the work of Nature.

The process of reasoning which led me to believe that the cavern owes its existence to the hand of man had little in common with the arguments by which the inference is now supported. In June, 1881, while examining the Giants' Causeway, it seemed evident that columnar basalt showed no tendency to erode and form hollows. Where the basalt, which for the height of some hundreds of feet above the chalk is quite amorphous, and caps the low promontories along the coast, is brought so low that more than one half of its thickness is immersed in the sea, the remainder projects above the water and forms the well-known natural pier. The caves on that coast are in the great

* A summary of an address made before the American Association for the Advancement of Science at Montreal, August 30th, and the Academy of Science at New York, October 9, 1882, illustrated by photographs and diagrams.

ochre-bed or chalk. They are plainly artificial in their present form. The peculiar Gothic door-way and the sheltered approach strengthen the view that they bear a distinct relation to an ancient civilization, and that it is not by accident that adjacent cliffs are crowned with castles, neighboring mines were worked from unknown periods, beacon-rocks bear mythological names, and manuscripts refer to maritime expeditions to the Baltic and Mediterranean. It seemed antecedently possible that the same race, Kelto-Iberian, Wend, or Phœnician, which had formed harbors on the coast of Ireland, might also have been the active agent in that perforation which has been termed the most remarkable in Europe. This conjecture received strong and unexpected confirmation. It was submitted to rigid examination; it was strengthened by opposition. It has been adopted, by a considerable number of eminent men, as a far stronger *prima facie* case than that commonly stated by the text-books in favor of marine erosion. If not well founded, it still suggests difficulties which have escaped observation, and may also correct the inaccurate terms in which Fingal's Cave has been described, and the imperfect representations which have gone far to perpetuate the hasty conclusion of Sir Joseph Banks.

Fingal's Cave is not at the Giants' Causeway. It is in the southern end of the Island of Staffa, whose apparent size and position are necessarily exaggerated on the maps in common use. It is not "off the

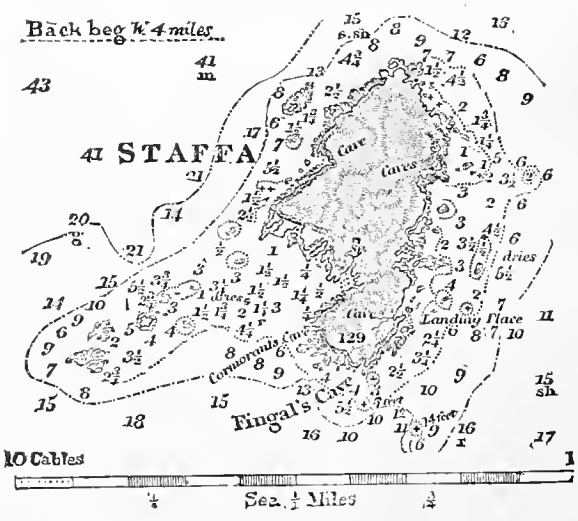


Fig. 1.—From the Admiralty Chart of Loch Tuadh.

southwest coast of Scotland." It is deeply embayed in a large sinuosity formed by the Island of Mull, and nearly inclosed on the opposite side by Iona and the Treshnish Islands. Beyond the latter a second line is drawn by Tiree and Coll, while to the north but to a greater distance are placed the islands of Minch, Rum, Eigg, and Canna. The

circle is completely closed for 315° by land, distant at farthest from five to seven miles. From Dutchman's Cap, bearing nearly due west, to the "Stac" off Iona, there is comparatively deep water of forty to fifty fathoms. The charts, however, show that rocks approach the surface. "Five-Fathom Rock," "Dangerous Overfalls," and soundings of less than ten fathoms, push half-way across the Passage of Tiree. Mackenzie's Rock, which dries in four feet, guards the other entrance, and no Atlantic surge could pass into Loch Tuadh or the Sound of Iona, without changing its direction twice and almost at right angles. But Donegal receives the impetus of the tremendous billows which break against the steep cliffs of Mizen Head, or rush up the narrow gorges with which the exposed coast of the Northern Hebrides is so deeply scored. Staffa is singularly sheltered. It makes it antecedently extremely improbable that this particular spot would be selected by the ocean as a place on which to "prove its strength." Wordsworth was both a landsman and a poet, and, as he says—

> "In a motley crowd, each the other's blight,
> Hurried and hurrying"—

only *saw* it. His language, however, has undoubtedly been made a vehicle of scientific error.

"Caves worn by the sea are due to the set of the currents, the force of the breakers, and the grinding of the shingle, which inevitably discover the weak places in the cliff, and leave caves as one of the results of their work, modified in each case by the local conditions of the rock" ("Encyclopædia Britannica"). Assuming that this is a complete statement of the law of marine erosion, how was Fingal's Cave "hollowed out of columnar basalt," and therefore rightly classed by Professor Boyd Dawkins, "among caves worn by the sea"? There is no current setting into this bay. The spring tides rise $11\frac{3}{4}$ feet, neaps 8 feet, and range $4\frac{1}{2}$ feet. The maelstrom of that part of the ocean is "where Corryvrechan's surges driven" make "the caldron of the spectral sea," but to the south, behind Colonsay. The force of the breakers is inconsiderable. Either they are the result of local disturbance formed to the east of Tiree, or the ground-swell and heaving of the sea after a storm. The island is fully protected by its own foreshore. The perpendicular columns suggest an "unknown profundity of depth." But the basalt on the west is over 50 feet above the sea-level. A spit of conglomerated trap or tufa prolongs under water a flat, rocky shore. There is a succession of rocks and shoals. The 20-fathom line is a mile distant, the 10-fathom half a mile, immediately followed by rocks, and 12, 15, and 9 feet of water. As the cave is in the southern face, it appears to be impossible, in the present state of the coast, that a wave with any momentum could strike directly upon that end of the island. As MacCulloch sat on one of the columns, though the long swell raised the water at intervals to his feet, the movement was silent, and the surface of the sea apparently undisturbed. There is

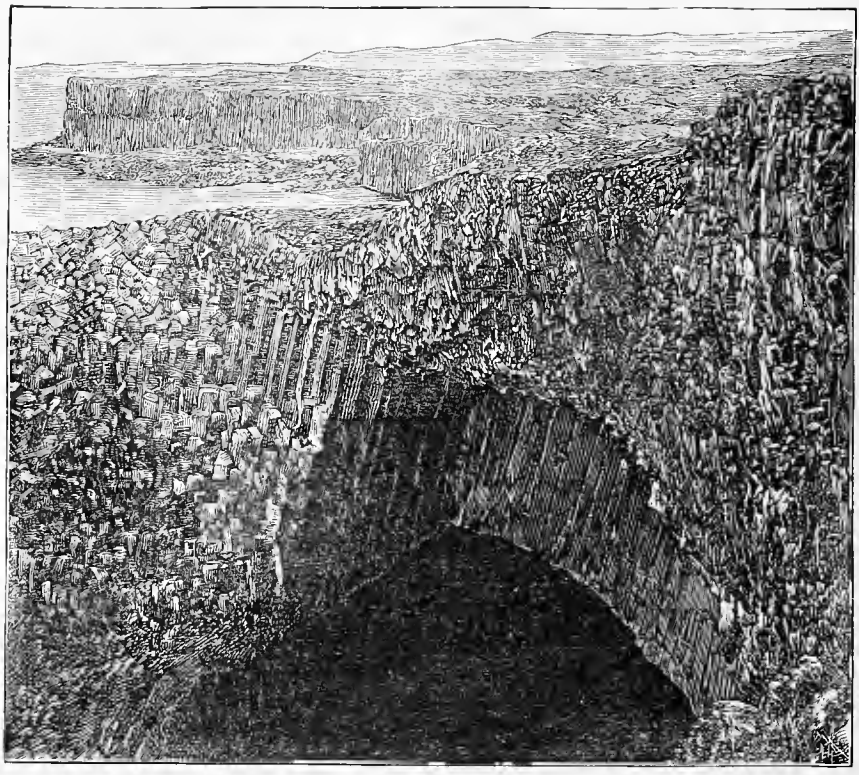


Fig. 2.—West Side of Staffa, 1863. G. W. W. Showing Arched Entrance to Cormorant's Cave.

no shingle. The prismatic blocks are refractory. If a wave struck with sufficient force to dislodge the drums, or if, undermining the tuff, it strewed the beach with hexagonal or pentagonal blocks, these smooth stones, with polished sides, buried in the finer material, would offer very great resistance to any further waste of the cliff. Although a channel of 18 feet at mean low water approaches and enters the cave, there is no ledge over which the material could have been carried. The sharp conchoidal fracture would not serve the purpose of such crystalline rocks as quartz or granite, and furnish the fluid wave with a serrated edge.

The cave is not formed in what would naturally be considered *the* cliff; least of all in its weakest place. After examining the Admiralty Chart, "the reader will, no doubt, pass with pleasure to the rich description by Dr. MacCulloch." That author, however, says that the whole of Fingal's Cave seemed like a ship heaving in a sea-way, and therefore his survey may be considered less trustworthy than that of Commanders Bedford and Creyke (Admiralty Chart, 1857). It seems incorrect to say, "The caves are so numerous that they may be said to perforate at brief intervals the whole face of the island; but those which

occur on the south (*sic*, query west) and the north sides are remarkable neither for beauty nor for magnitude." The caves are sufficiently numerous to furnish an argument. There are very few hollows worn by the sea in the Scotch coast. The islet, which contains a dozen, has not the $\frac{1}{100000}$ part of the indented line of the mainland, and bears an infinitesimal ratio to the sea-board, including the islands. Its parent, Mull, within whose bosom rests this irregularly oval rock, "measuring about one and a half mile in circumference," has in the dimension of length one hundred and fifty times better right to a "museum of wonders." The "Isle of Columns" is a speck too tiny to show on any ordinary map. The chance that it would contain, as a legitimate yet exceptional result of normal contact between igneous rock and sea-water agitated by wind, "the most remarkable cave in Europe," is less than 0. It is the $\sqrt{-1}$.

The uneven table-land is formed of "three distinct beds of rock of unequal thickness, inclined toward the east at an angle of about nine degrees. The lowest is a rude trap tufa, the middle one is divided into columns placed vertically to the plane of the bed, and the uppermost is an irregular mixture of small columns and shapeless rock." The columnar bed is never more than 60 feet thick. The island itself attains a maximum height of 129 feet. It has no peak from which rain-water might descend in a considerable quantity. There is no series of fissures corresponding to the perforations. There is nothing on the flat top to suggest the tunnels beneath. Proceeding toward the south from the landing-place, there are six cases of alleged erosion, each presenting its own seemingly insuperable difficulty, and cumulatively requiring a more thoughtful and serious consideration than the fantastic phrases in which 'stupendous (!) columns, three feet thick and thirty feet high, rise from a *dark-red* or violet-colored rock over which *the ocean* rolls, and reflects from its *white* bottom a variety of *crimson* and *yellow*.'

It appears now to be well established that the peculiar structure of columnar basalt is due to contraction and splitting consequent upon cooling. The analogy is rather to the splitting often seen in the mud bottom of a dried-up pool than to ordinary crystallization. The various conditions point to the contractile origin of the structure, at the same time that the result suggests a curious mimicry of imperfect crystallization. If the cooling mass of basalt be in one of its vertical sections of such a form that successive isothermal *couches*, taken in descending order, are not parallel to the original cooling surface, as they are in all cases of straight and parallel prisms, but divergent gradually from the cooling surface and from each other, then the lines of the splitting of the prisms, always true to these *couches*, must be curved in one direction. This will be true, whether the isothermal *couches* be plane surfaces divergent from a thinner to a thicker part of the mass, or whether they be curved surfaces arising from the mass reposing on

a curved bottom and diverging in like manner. The *crux* of Staffa is Scallop or Clamshell Cave. Inattention has caused the various authors to describe it as if there was nothing astonishing in the sudden interruption of the columns, which are "bent so as to form on one side a

Fig. 3.—Fingal's Cave, Staffa, 1111. J. V.

series of ribs not unlike an inside view of the timbers of a ship," while "the opposite wall is formed by the ends of columns, and bears a general resemblance to the surface of a honey-comb." Sixteen feet wide,

130 feet long, how could the sea attack the landward, southeast end, and carve a trench 45 to 50 feet deep, where it is geologically impossible that a "fault" or "weak place" aided the natural force? The channel of Bouchaillie, seen from the cliff above, is a canal cut through the columnar basalt, and taking a slice from that conoidal pile of columns about thirty feet high, which is seen a few yards to the right of the Colonnade and Fingal's Cave. Where is the *débris?* Why should it be crossed at right angles by the passage leading into the Clamshell Cave? The Causeway here presents an extensive surface, which terminates in a long, projecting point at the eastern side of the Great Cave. It is formed normally. The heads of columns show in a compact and serried phalanx. Each row protects the other in turn. The tesselated pavement, as on the Irish coast, is a firm, impenetrable mass, showing by its steepness its utter contempt for the wavelets which could not break those ranks in a geological æon. There is nothing to prepare the scientific mind, distrustful of abrupt changes, for the adjacent excavation. Its dimensions are, from the top of the arch to the cliff above, 30 feet; to the water, 66 feet; to the bottom, 88 feet. Its breadth of 42 feet continues to within a small distance of the inner extremity, when it is reduced to 22 feet. The total length is 227 feet.

It is usually said to have been formed by erosion at the base. The columns, falling, dragged down a part of the roof, aided by a fissure which divides the ceiling. The tuff is not eroded even at the southwest end of the island. These pillars, however strong and enduring, are each composed of many separate joints or pieces, built up one upon another. They do not adhere in any way together, but merely rest mechanically upon each other, and are easily detachable. The capitals beyond cling to the roof. There is no fissure. In Boat Cave, tuff is undermined for 1,800 square feet, yet the columns stand wedged across 12 feet of width. At Tanaga Island, in the Aleutian group, the broken columns form a slightly *convex* roof across an opening 20 feet wide. No such Gothic arch was ever formed by Nature. It is strikingly Phœnician. No natural cave has an entrance higher than the interior. A tidal or earthquake wave would not reach the top of the arch. The cave is post-glacial. The upheaval of that part of Scotland is put at 25 feet. It would not bring the confused basalt within reach of the waves. Their breaching power is easily calculated. It is determined in this case by the frail wall to the east. For a merciless ocean selecting this victim of his fury, and

> "Down-bearing with his whole Atlantic weight
> Of tide and tempest on the structure's base,"

and "flashing to that structure's topmost height," in his blind frenzy would have swept through the loose drums to the right. Montalembert thought it far inferior to any cathedral, or even a monastic church such as Cluny or Vezelay. If "raising (!) a minster," it would have

been better to put all the chapels under one roof. The horizontal and perpendicular sections are equally at variance with the curved surface formed by a fluid in vibration. The columnar basalt would form a

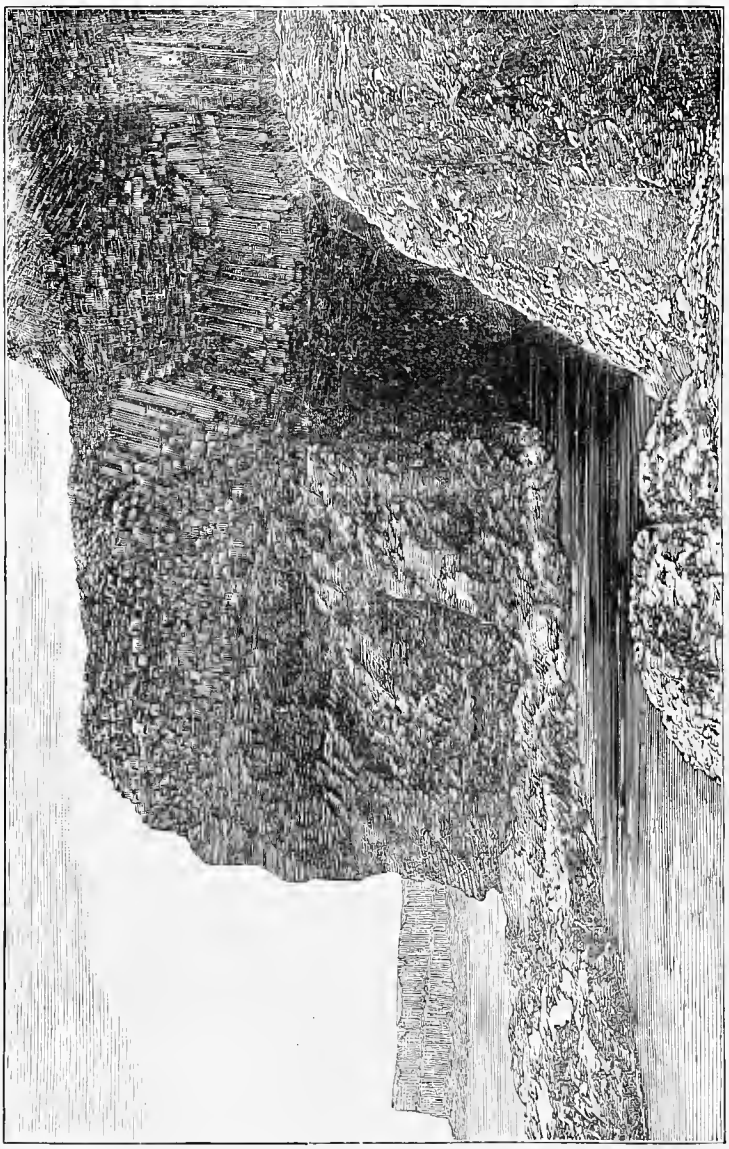


Fig. 4.—Cormorant's Cave, Staffa, 1861. G. W. W.

curved and not a rectangular water-line. What other cavern has a uniform breadth from the opening, and five and a half diameters in length?

Cormorant's or Mackinnon's Cave is easy of access, and terminates

in a "gravelly" beach, where a boat may be drawn up. It is 50 feet high, 48 feet broad, and 224 feet long. It is excavated in the lower stratum. Thus two tunnels of the same dimensions are supposed to have been driven into two different materials by the same force. The interior dimensions are nearly the same to the end. As no sentimental or religious motive can be assigned to Nature for *this* freak, it is amenable to comparison. The Blue Grotto of Capri is typical. Its entrance is scarcely three feet in height; in the interior the roof rises to a height of 41 feet; the water is 8 fathoms deep; length of the grotto,

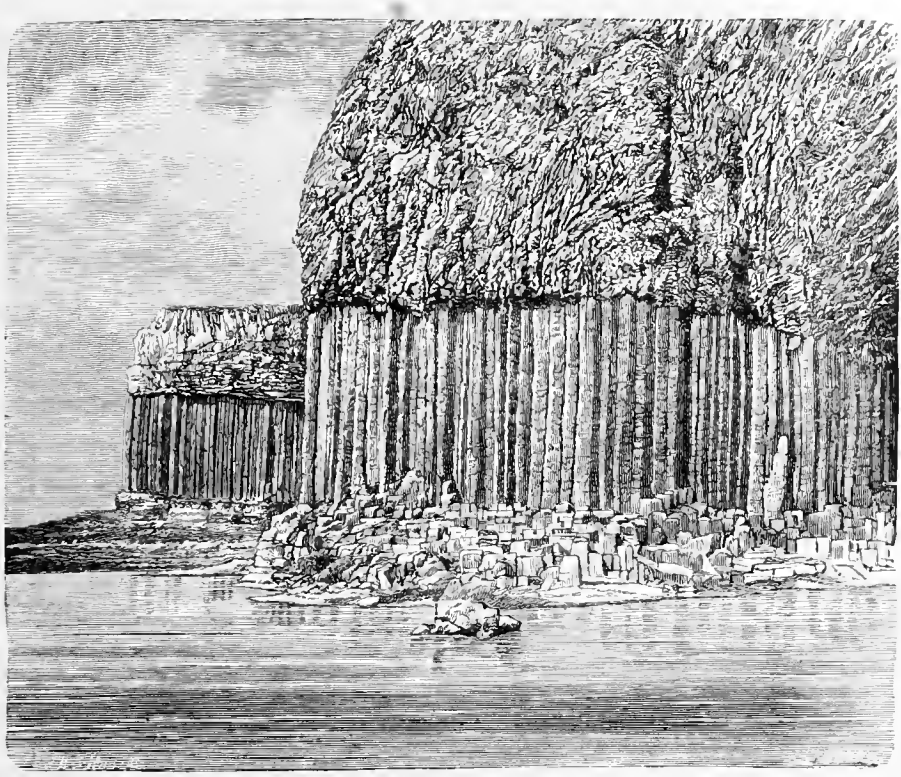
Fig. 5.—Fingal's Cave (looking out), showing Iona, distant Six Miles.

175 feet; greatest width, 100 feet. Here the great size of the aperture is further increased. The superior part of the front, penetrating into the columnar basalt, has hollowed a recess above the main opening. The same Gothic tympanum, distorted by the material, not only marks its artificial origin, but disproves the allegation that the columns could not form a natural architrave. The Boat Cave is accessible only by sea. It is a long opening, resembling the gallery of a

mine, excavated also in the tuff. Its height being about 16 feet (above the sea?), its breadth 12, and its depth about 150, it offers, in its proportion of twelve and a half diameters, the greatest contradiction to all other instances of sea-worn homogeneous rock.

But not only do Cormorant's and Fingal's Cave, each protected by its breakwater, face the adjacent land and not the open sea, and that land the far-famed Island of Iona, center of art and civilization, "dear to Christendom for more than a thousand years," but from the end of this deep cavity, to which a boat may sail in any ordinary weather, the "Dun" or Hill of "Hy" or Iona rises against the sky, in the middle of the arc of a few degrees subtended by the grand doorway. Until it is shown that a thousand yards of landlocked, iron-bound coast can be cut and tunneled in utter disregard of every known law of mechanical action, the caves in Staffa, on the west coast of Scotland, driven into igneous rock, not modified by local conditions, or in the weak places "of an exposed cliff," can not be classified as merely remarkable instances of caves worn by the sea. Had the learned duke who commenced his description of Iona with these words, "No two objects of interest could be more absolutely dissimilar in kind than the two neighboring islands of Staffa and Iona," "mixed Celtic memories with the Phrygian mount," recalled Athos, Tyre, and Carthage, or even the twin Island of Lerins, he might have hesitated to put them in sharp antithesis to say that only an accident of geography could unite their names, or with "the mighty surge" of personal and social authority drowned the faint cry for relief which reached his ears, and declined even to consider the solution here offered of a problem whose complex factors he had so forcibly stated.

From "THE EARTH AND ITS INHABITANTS."



The Exterior of Fingal's Cave.

D. APPLETON & CO., NEW YORK.


6°
Tarbet Ness
DORNOCH
TAIN
BURRAY FIRTH
CROMARTY
NAIRN
Dingwall
INVERNESS
Caledonian Canal
Rassay I.
RUM I.
Eigg I.
Muck I.
Ben Nevis
GRAMPIAN
Loch Lynhe
Firth of Lorn
INVERARY
57°
56°
W. of Gr.
10°20'
9°20'

GLENMORE.